PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : H04N 5/58 // 5/14	A1	(11) International Publication Number: WO 99/04562 (43) International Publication Date: 28 January 1999 (28.01.99)

(21) International Application Number: PCT/IB98/00658

(22) International Filing Date: 30 April 1998 (30.04.98)

(30) Priority Data:
97202202.4 14 July 1997 (14.07.97) EP
(34) Countries for which the regional or international application was filed: NL et al.

(71) Applicant: KONINKLIJKE PHILIPS ELECTRONICS N.V. [NL/NL]; Groenewoudseweg 1, NL-5621 BA Eindhoven (NL).

(71) Applicant *(for SE only)*: PHILIPS AB [SE/SE]; Kottbygatan 7, Kista, S-164 85 Stockholm (SE).

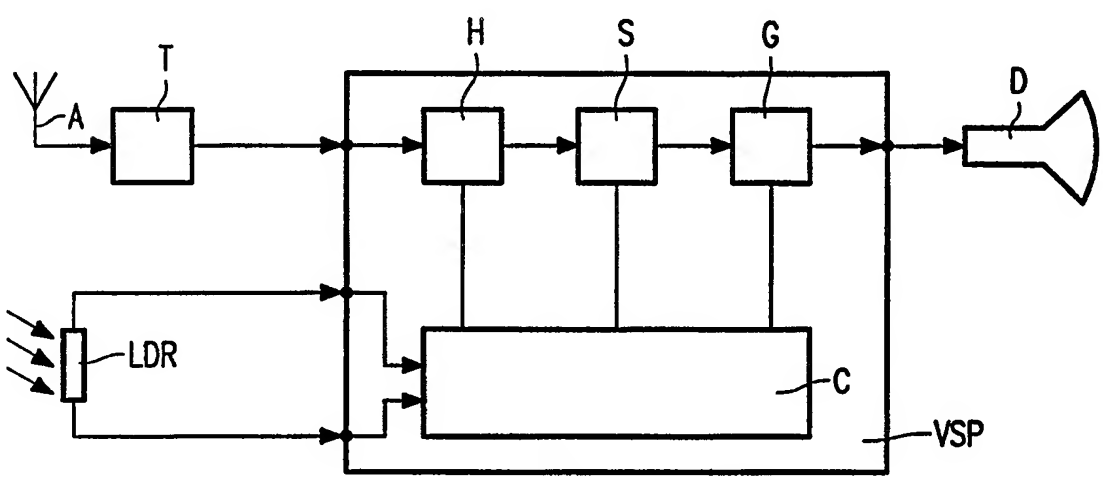
(72) Inventors: BARTH, Paul, John; Prof. Holstlaan 6, NL-5656 AA Eindhoven (NL). NIEUWENHUIZEN, Michel, Wouter; Prof. Holstlaan 6, NL-5656 AA Eindhoven (NL).

(74) Agent: STEENBEEK, Leonardus, J.; Internationaal Octrooibureau B.V., P.O. Box 220, NL-5600 AE Eindhoven (NL).

(81) Designated States: JP, KR, European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published
With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: AMBIENT LIGHT-DEPENDENT VIDEO-SIGNAL PROCESSING



(57) Abstract

In an ambient light-dependent video-signal processing method comprising the steps of measuring (LDR) an amount of ambient light to obtain a measured amount of ambient light, and processing (VSP) a video signal in dependence upon the measured amount of ambient light, the video signal is substantially immediately affected when there is a large change in the measured amount of ambient light, while the video signal is affected upon an occurrence of a scene change when there is a small change in the measured amount of ambient light.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania
AM	Armenia
AT	Austria
AU	Australia
AZ	Azerbaijan
BA	Bosnia and Herzegovina
BB	Barbados
BE	Belgium
BF	Burkina Faso
BG	Bulgaria
BJ	Benin
BR	Brazil
BY	Belarus
CA	Canada
CF	Central African Republic
CG	Congo
CH	Switzerland
CI	Côte d'Ivoire
CM	Cameroon
CN	China
CU	Cuba
CZ	Czech Republic
DE	Germany
DK	Denmark
EE	Estonia
ES	Spain
FI	Finland
FR	France
GA	Gabon
GB	United Kingdom
GE	Georgia
GH	Ghana
GN	Guinea
GR	Greece
HU	Hungary
IE	Ireland
IL	Israel
IS	Iceland
IT	Italy
JP	Japan
KE	Kenya
KG	Kyrgyzstan
KP	Democratic People's Republic of Korea
KR	Republic of Korea
KZ	Kazakstan
LC	Saint Lucia
LI	Liechtenstein
LK	Sri Lanka
LR	Liberia
LS	Lesotho
LT	Lithuania
LU	Luxembourg
LV	Latvia
MC	Monaco
MD	Republic of Moldova
MG	Madagascar
MK	The former Yugoslav Republic of Macedonia
ML	Mali
MN	Mongolia
MR	Mauritania
MW	Malawi
MX	Mexico
NE	Niger
NL	Netherlands
NO	Norway
NZ	New Zealand
PL	Poland
PT	Portugal
RO	Romania
RU	Russian Federation
SD	Sudan
SE	Sweden
SG	Singapore
SI	Slovenia
SK	Slovakia
SN	Senegal
SZ	Swaziland
TD	Chad
TG	Togo
TJ	Tajikistan
TM	Turkmenistan
TR	Turkey
TT	Trinidad and Tobago
UA	Ukraine
UG	Uganda
US	United States of America
UZ	Uzbekistan
VN	Viet Nam
YU	Yugoslavia
ZW	Zimbabwe

Ambient light-dependent video-signal processing.

The invention relates to ambient light-dependent video-signal processing, and to a display apparatus featuring ambient light-dependent video-signal processing.

WO-A-94/18,790 discloses an environment-dependent automatic luminance control for display screens, providing the possibility of automatically and continuously adjusting the luminance of the display screen to the average luminance in the user's field of view. The display screen is coupled to an external light sensor which can be placed individually anywhere in the room and is adjusted in such a way that the spatial angle covered roughly corresponds to the user's field of view. An electronic control built into the display or connectable thereto via an interface ensures that the brightness, contrast or background illumination of the display screen is adjusted so that the luminance of the display screen is in the best possible relationship with the average luminance in the field of view.

It is, *inter alia,* an object of the invention to provide a better ambient light-dependent video-signal processing. To this end, a first aspect of the invention provides an ambient light-dependent video-signal processing method as defined by claim 1. A second aspect of the invention provides an ambient light-dependent video-signal processing device as defined by claim 9. A third aspect of the invention provides a display apparatus as defined by claim 10. Advantageous embodiments are defined in the dependent claims.

In a method of ambient light-dependent video-signal processing in accordance with a primary aspect of the present invention, the method comprising the steps of measuring an amount of ambient light to obtain a measured amount of ambient light, and processing a video signal in dependence upon the measured amount of ambient light, the video signal is substantially immediately affected when there is a large change in the measured amount of ambient light, while the video signal is affected upon an occurrence of a scene change when there is a small change in the measured amount of ambient light.

It is to be noted that WO-A-90/06035 discloses a picture receiver

controller in which data signals are subjected to an operation in such a way that a noise reduction control signal is outputted in conformity with a noise level introduced during transfer or storing, further comprising means for updating the noise reduction control signal in synchronism with a scene change of an input image,so that a smooth noise reduction control can be performed when a detected noise level is quantized and controlled synchronously with a detected scene changing state. This document does not teach that the video signal is substantially immediately affected when there is a large change in the measured amount of ambient light, while the video signal is only affected upon an occurrence of a scene change when there is a small change in the measured amount of ambient light.

These and other aspects of the invention will be apparent from and elucidated with reference to the embodiments described hereinafter.

In the drawings:

Fig. 1 shows an embodiment of a display apparatus in accordance with the present invention; and

Fig. 2 is a graph (contrast versus ambient light) illustrating the operation of an embodiment of an ambient light-dependent video-signal processor in accordance with the present invention.

Fig. 1 shows an embodiment of a display apparatus in accordance with the present invention. An antenna A picks up a television signal and applies it to a tuner T which furnishes a baseband video signal. An ambient light-dependent video-signal processor VSP processes the video signal received from the tuner T and applies a processed video signal to a display device D.

The ambient light-dependent video-signal processor VSP receives a signal indicating a measured amount of ambient light from a light-dependent resistor LDR or some other light sensor such as a photo diode. The measured amount of ambient light-indicating signal is applied to a control circuit C, which furnishes control signals to a cascade connection of a histogram-based processing circuit H, a saturation control circuit S, and a gain circuit (variable amplifier) G, by which circuits H, S and G the video signal is processed in the ambient light-dependent video-signal processor VSP.

The control circuit C controls the circuits H, S and G in such a manner

that the video signal is substantially immediately affected when there is a large change in the measured amount of ambient light, while the video signal is only affected upon an occurrence of a scene change when there is a small change in the measured amount of ambient light. The scene change dependency prevents ambient light-dependent control-setting changes from becoming annoyingly visible, while large control-setting changes (the light in the room is turned on/off, the sun hides behind a cloud, or reappears from behind a cloud) are immediately effected so that the person watching the TV continues to have optimum viewing conditions.

When there is a large change in the measured amount of ambient light, a first large adjustment is made, followed by a small adjustment completing the adjustment necessary in view of said large change in said measured amount of ambient light. In this manner, the control speed of the ambient light control is matched with the adaptation speed of the human eye. By matching the control speed to the eye, the visibility of the control can be diminished. Experiments proved that, when the lights in a room are switched off, it takes some minutes for the eye to get used to the new situation. If the TV picture reduces its contrast much faster, this may lead to irritation because the picture may look dull for a few minutes. In this embodiment, the small adjustment is preferably effected upon an occurrence of a scene change. Mainly going from light to dark, the eye can be quite slow, so that the necessary adjustment is preferably only divided into an immediate large adjustment followed by a small complementary adjustment if the measured amount of ambient light undergoes a large change from light to dark.

Fig. 2 is a graph (contrast versus ambient light) illustrating the operation of an embodiment of an ambient light-dependent video-signal processor in accordance with the present invention. Ambient light (AL) is plotted (logarithmically) on the horizontal axis, while contrast CT is plotted (logarithmically) on the vertical axis. The upper curve 1 shows how contrast is changed by gain adaptation (up to a first ambient light value V1), by doing nothing (between V1 and V2) as the maximum amount of global contrast achievable by the display and the gain circuit has already been achieved, and by histogram / saturation adaptation (from a second ambient light value V2). The lower curve 2 illustrates how an increasing amount of ambient light deteriorates the perceived contrast PC for the user, as the perceived contrast PC is the difference between the curves 1 and 2: it can easily be seen that, from V1, when the gain is maximum, an increasing amount of ambient light results in a decreasing distance between the curves 1 and 2, i.e. in a reduced amount of perceived

contrast. The arrow PC1 illustrates the amount of perceived contrast at a low amount of ambient light AL, while the arrow PC2 illustrates the amount of perceived contrast at a high amount of ambient light AL.

In the ambient light range up to the first ambient light value V1, contrast changes are preferably effected in dependence upon the amount of ambient light by modifying the gain by means of the gain circuit (variable amplifier) G. This is based on the following considerations. Present-day TV sets have a high peak-white output. When the viewer is present in dark surroundings (and his/her eyes are adapted to the dark), this high peak-white output can become tiring. Under dark ambient conditions, it is therefore better to reduce the contrast to some extent. The resulting image is less fatiguing to the eye. It appeared that, only when the measured amount of ambient light is below the first given value V1, it was necessary to delay the ambient light-dependent video-signal processing until the occurrence of a scene change.

In the ambient light range from the second ambient light value V2, contrast changes are preferably effected in dependence upon the amount of ambient light by means of the histogram-based processing circuit (non-linear amplifier) H of Fig. 1. Preferably, a circuit of the type set out in US-A-5,537,071 (Attorneys' docket PHN 14,650) and EP-A-0,648,043 (Attorneys' docket PHN 14,586) is used for this purpose. An ordinary amplifier easily allows reduction of the contrast when the ambient light diminishes. However, if more light from the display device D is required when the ambient light exceeds the value V2, this requirement can often not be met because the total light output of the display device D is already at its maximum value. In such circumstances, a further locally perceived contrast increase can still be obtained by means of the histogram-based processor H because such a circuit can highlight interesting parts (luminance levels) in the picture to the detriment of less interesting parts, so that the locally perceived contrast is still increased while the total light output of the display device D remains at about the same level. This mechanism is very well suited for ambient light control under bright conditions because, when there is much ambient light, the viewer is no longer interested in the details (background etc.), but just wants to see what is going on. Under extreme ambient light conditions, the natural appearance of the picture is no longer relevant or interesting and even extreme non-linear amplifier settings are allowed.

Under high ambient light conditions, there are many reflections coming back from the TV screen. These reflections are mainly whitish. This results in a perceived decrease of the saturation of the television picture. To compensate for this effect, the

saturation (controlled by saturation control circuit S) should slightly increase at high ambient light conditions. A small correction (maximally 5 steps out of a 64 step control range) is therefore preferably added to a user setting.

It should be noted that the above-mentioned embodiments illustrate rather than limit the invention, and that those skilled in the art will be able to design many alternative embodiments without departing from the scope of the appended claims. Any changes in the video-signal processing settings to be carried out upon an occurrence of a scene change may be subdivided into several partial setting changes which are carried out sequentially in response to sequential scene changes. In the claims, any reference signs placed between parentheses shall not be construed as limiting the claim. The invention can be implemented by means of hardware comprising several distinct elements and by means of a suitably programmed computer. In the device claim enumerating several means, several of these means can be embodied by one and the same item of hardware.

CLAIMS:

1. An ambient light-dependent video-signal processing method comprising the steps of:

measuring (LDR) an amount of ambient light to obtain a measured amount of ambient light;

processing (VSP) a video signal in dependence upon said measured amount of ambient light; wherein

said processing step (VSP) includes the steps of:

substantially immediately affecting said video signal when there is a large change in said measured amount of ambient light; and

affecting said video signal upon an occurrence of a scene change when there is a small change in said measured amount of ambient light.

2. A method as claimed in claim 1, wherein when there is a large change in said measured amount of ambient light a first large adjustment is made, followed by a small adjustment completing the adjustment necessary in view of said large change in said measured amount of ambient light.

3. A method as claimed in claim 2, wherein said small adjustment is effected upon an occurrence of a scene change.

4. A method as claimed in claim 2, wherein the necessary adjustment is only divided into an immediate large adjustment followed by a small complementary adjustment if said measured amount of ambient light undergoes a large change from light to dark.

5. A method as claimed in claim 1, wherein said ambient light-dependent video-signal processing is only delayed until the occurrence of a scene change when the measured amount of ambient light is below a first given value (V1).

6. A method as claimed in claim 1, wherein said ambient light-dependent video-signal processing involves a gain adaptation (G) when the measured amount of ambient light is below a second given value (V1).

7. A method as claimed in claim 1, wherein said ambient light-dependent video-signal processing involves a histogram-based operation (H) when the measured amount of ambient light is above a third given value (V2).

8. A method as claimed in claim 1, wherein said ambient light-dependent video-signal processing involves a saturation adaptation (S) when the measured amount of ambient light is above a fourth given value (V2).

9. An ambient light-dependent video-signal processing device comprising:

means (LDR) for measuring an amount of ambient light to obtain a measured amount of ambient light;

means (VSP) for processing a video signal in dependence upon said measured amount of ambient light; wherein

said processing means (VSP) include:

means for substantially immediately affecting said video signal when there is a large change in said measured amount of ambient light; and

means for affecting said video signal upon an occurrence of a scene change when there is a small change in said measured amount of ambient light.

10. A display apparatus, comprising:

an ambient light-dependent video-signal processing device (VSP) as claimed in claim 9; and

a display device (D) for displaying the video signal processed by the ambient light-dependent video-signal processing device (VSP).

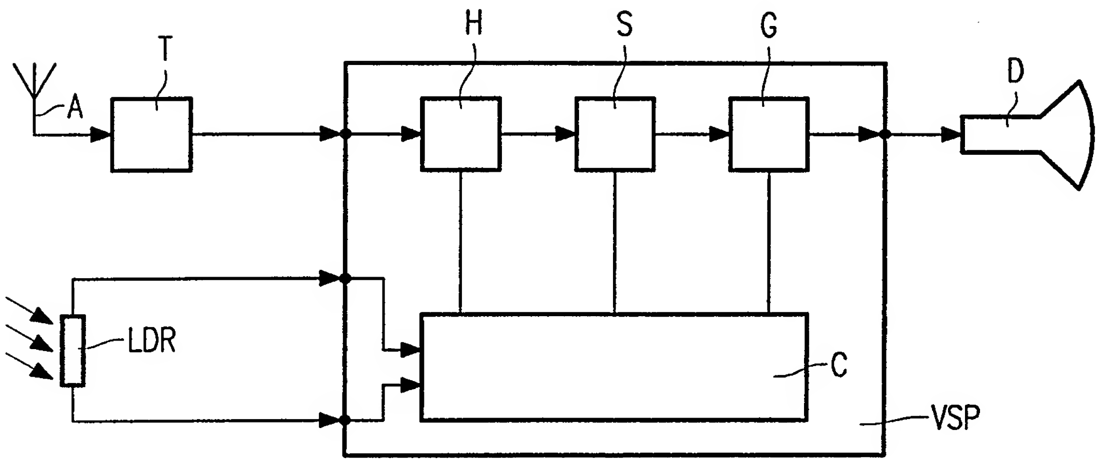


FIG. 1

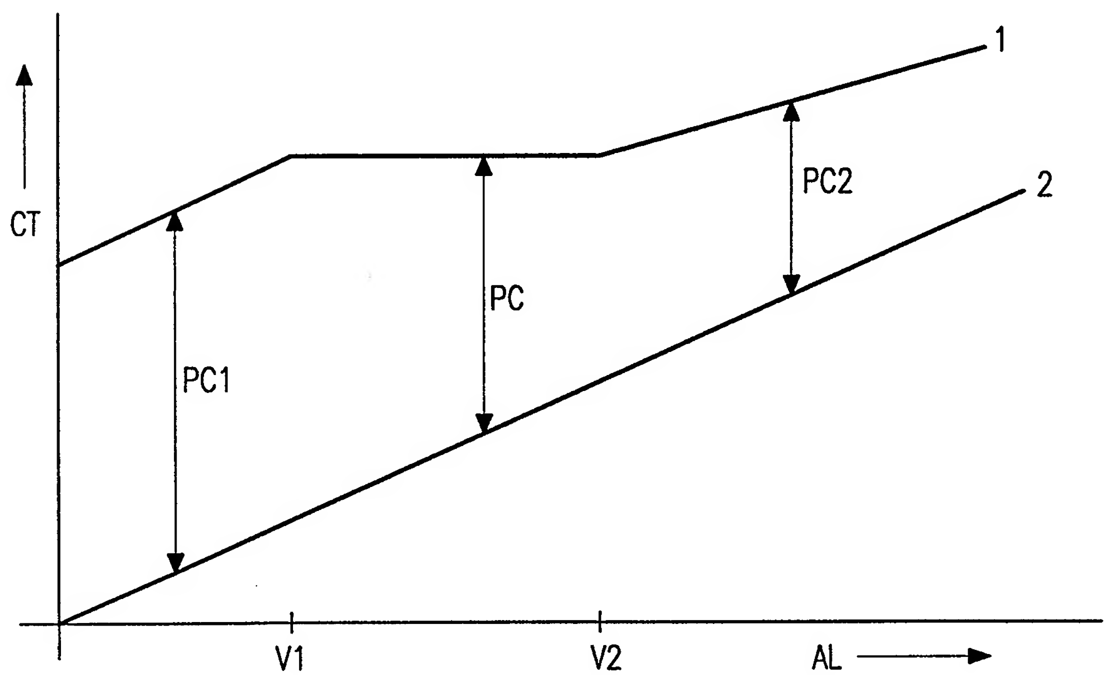


FIG. 2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IB 98/00658

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: H04N 5/58 // H04N 5/14
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: H04N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	Patent Abstracts of Japan, abstract of JP 6-62345 A (MATSUSHITA ELECTRIC IND CO LTD), 4 March 1994 (04.03.94) --	1-10
A	WO 9418790 A1 (BARATH, LUDWIG), 18 August 1994 (18.08.94), abstract --	1-10
A	US 5537071 A (CORNELIS A.M. JASPERS), 16 July 1996 (16.07.96), abstract --	1-10
A	EP 0648043 A1 (PHILIPS ELECTRONICS N.V.), 12 April 1995 (12.04.95), abstract -- --------	1-10

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" erlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
27 November 1998	30 -11- 1998
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Michel Gascoin Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/IB 98/00658

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9418790 A1	18/08/94	AU 5856194 A	29/08/94
US 5537071 A	16/07/96	BE 1007777 A	17/10/95
		EP 0654942 A	24/05/95
		JP 7202608 A	04/08/95
EP 0648043 A1	12/04/95	BE 1007608 A	22/08/95
		JP 7177387 A	14/07/95
		US 5734746 A	31/03/98